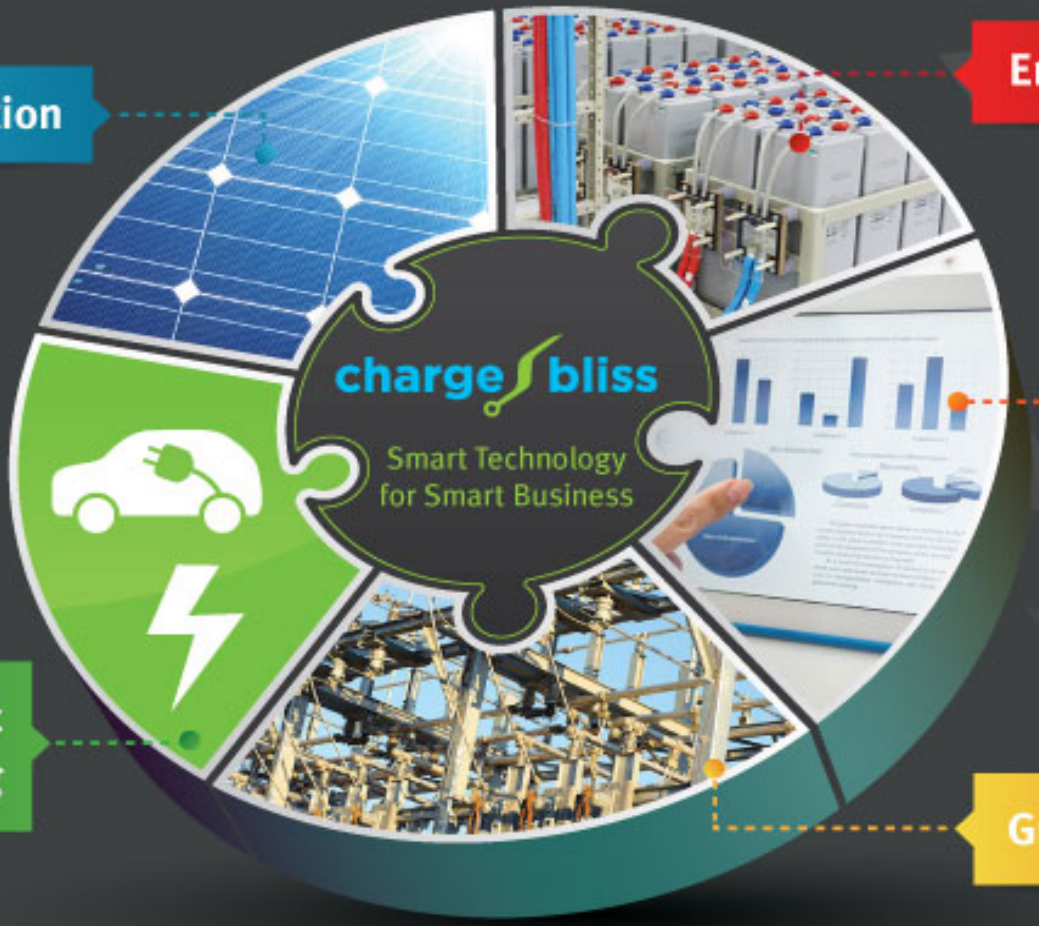
Energy Ecosystem



Energy Generation

Energy Storage

Energy and Demand Management

Fast Electric Vehicle Charging

Grid Supply

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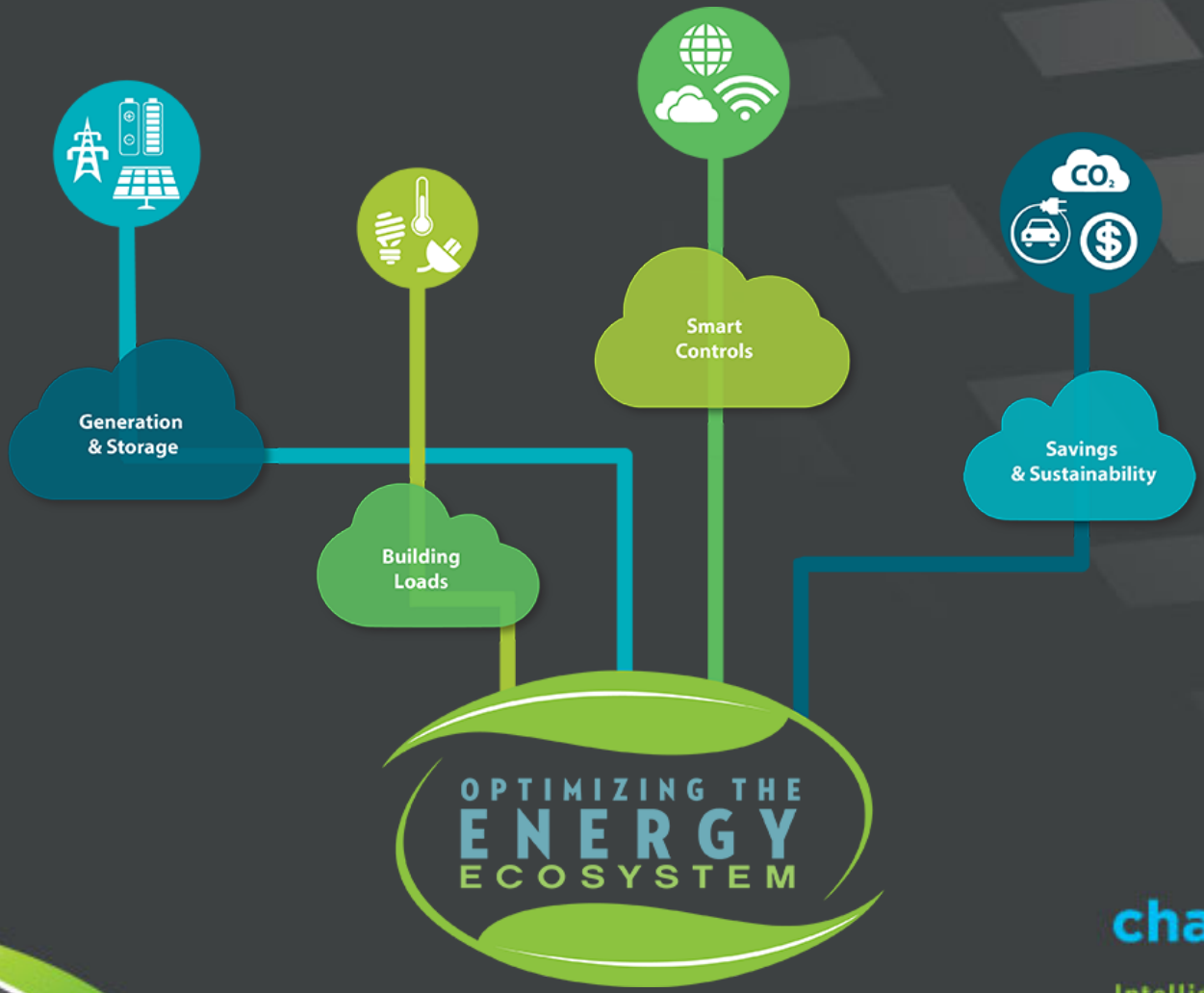
Getting to (near) Zero:

Greening Hospital Power, Improving System Reliability, Preserving Safety and Effectiveness through Renewable Energy Microgrids



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Host Hospital
Kaiser Permanente Richmond

- **50-bed, acute care hospital (part of single license with Oakland providing over 300 beds)**
  - **Only hospital in Western Contra Costa**
  - **Adult Critical care, Emergency room, community health initiatives**
  - **OSHPD-governed**
- **Richmond, California (East Bay)**
  - http://www.ci.richmond.ca.us/DocumentCenter/Home/View/8348 .

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Definitions and Significance

Why Micro Grids and Hospitals?

- **Hospitals are intensive users of Power (kW) and Energy (kWh) in the service of health**
- **Group 1 CEC 14-301: Microgrids for *Critical Facilities- Kaiser Richmond***

Energy Use

- Recent Federal Government Reports on hospital energy consumption stated the following:

  The 2003 Commercial Building Energy Consumption Survey (CBECS) data showed that large hospitals (greater than 200,000 square feet) accounted for less than 1 percent of all commercial buildings and 2 percent of commercial floor space, but consumed 4.3 percent of the total delivered energy used by the commercial sector in 2003. Data from the 2007 CBECS show that the major fuels (electricity, natural gas, fuel oil, and district heat) consumed by large hospitals totaled 458 trillion Btu, which is 5.5 percent of the total delivered energy used by the commercial sector in 2007.

  – EIA August 2008 Report

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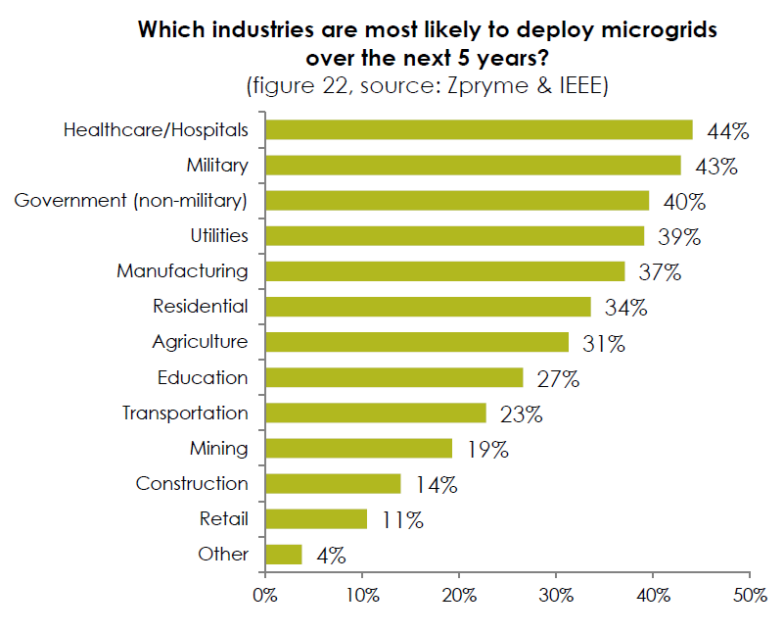


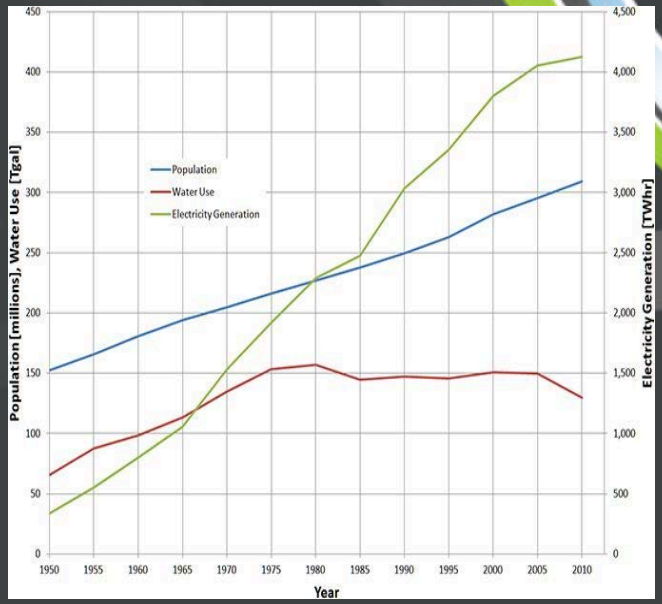
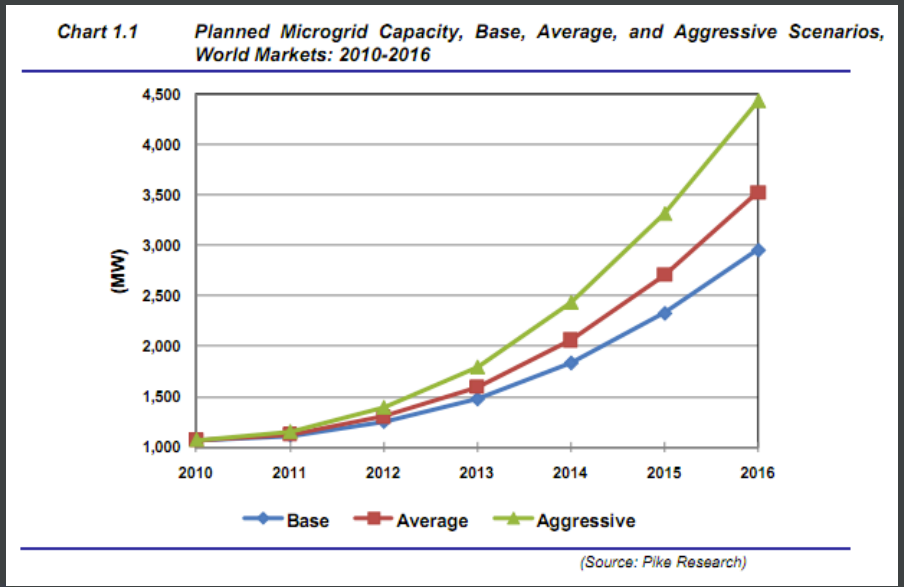


Figure 1. US population, water use, and electricity generation from 1950 to 2010 data show that the increase in electric-grid utilization has far outpaced population growth as virtually all sectors of society have adopted ever-greater numbers of electronic devices. (Sources: Census Bureau, US Dept of Commerce; US Geological Survey; Energy Information Administration, US Dept of Energy)



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Project Goals

1. Identify and surmount obstacles to healthcare facility microgrids

2. Demonstrate hospital microgrids value to utility ratepayers

3. Develop a commercializable supervisory microgrid controller and demonstrate use cases

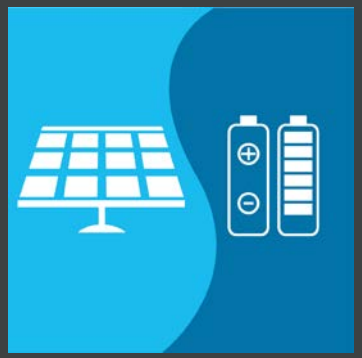
Objectives for Hospital Benefit

1. ***Energy production:*** 365,000kWh/year valued at $0.15/kWh = $54,750/year initial savings

2. ***Arbitrage of power:*** 900kWh/day at price differential average $0.03/kWh (weekdays) = $7,884/year initial savings.

3. ***Demand reduction:*** 100-200kW at $25/kW = $30,000-$60,000/year savings

4. ***Power efficiency:*** Through power quality regulation, may achieve up to 20% operational efficiency. Assuming average demand = 1.5MW, savings may reach 2.63MWh = $394,000/year



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Objectives for Hospital Benefit

5. ***Automated Demand Response (ADR):*** **$200-$400/kW at 200kW per episode = $40,000-$80,000/year payments..**

6. ***CAISO Rapid Power Quality:*** **Contract value TBD**

7. ***Decreased use of Backup Diesel:*** **Savings per 1-hour of avoided diesel usage at $0.50/kWh produced, 1.5MW demand = $750/hour.**

VALUE OF SAVINGS ESCALATES AS UTILITY COSTS AND RATES RISE (HEDGE)

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INDIRECT BENEFITS

- Improved power quality = 20% efficiency (de Callafon- UCSD)
- Decreased unplanned opening of ATS + DER downtime
  - Fewer care disruptions
  - Less unplanned diesel run time
  - Less off-time for solar/cogeneration/wind and other resource inverters
  - Fewer GHG emissions
- OVERALL- INCREASED RELIABILITY, DECREASED COST, AND LESS ENVIRONMENTAL IMPACT

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HEALTHCARE FINANCE

- Lower costs of healthcare system operations
  - 45% of hospitals had NEGATIVE operating margins in 2007
  - California has one of the lowest ratios of beds to population in the Country
- MANY critical facilities at risk of closing
  - Few means to curb cost while preserving service other than Energy/Power

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Microgrid at Kaiser Richmond

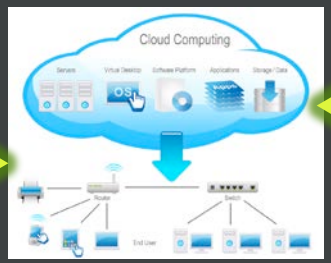
Principles:

1. Charge Bliss Controller monitors and administers discretionary load items
2. OSI/PI Server iterative analytics with NREL, builds microgrid controller
3. Clean energy made, stored, distributed to optimize entire "ecosystem"

Hospital

Photovoltaic

PI Server



NREL

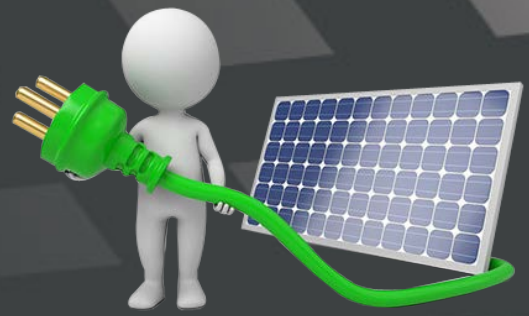
OSIsoft.
Infrastructure

PCS

Batteries

Special Consideration- Office of Statewide Health Planning and Development

- Governs all hospital design, construction, and operation



- Special emphasis on:
  - Electrical system safety and effectiveness
  - Life and Safety/Critical circuit Primacy
  - Recognize and incorporate involving technologies and create appropriate standards

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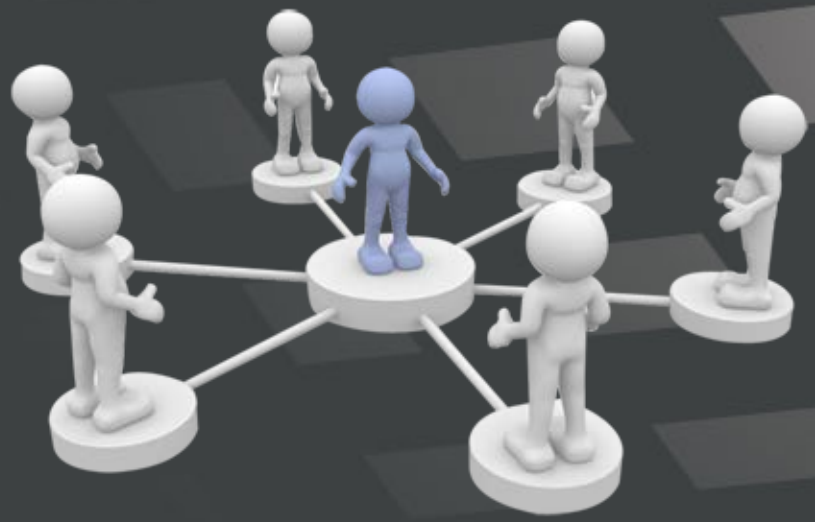
ACCOMPLISHMENTS TO DATE

- Completed and submitted designs for parking structure solar, battery room, interconnection to City, OSHPD
- Received OSHPD encouragement to support emergency circuit
- Acquired physical systems and have planned monitoring and control architectures



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CHALLENGES AND OBSTACLES

- Hospitals VERY LEERY of new technologies and OSHPD response
- Space and code constraints limit options for batteries and solar
- Changing from containerized inverter/battery system to a constructed CMU block room
- Electrical bus tolerances
- Coordination of site administration, building management, and engineering with Charge Bliss design team and suppliers required extensive and sometimes redundant communication
- Fire Suppression system requirements/standards/recommendations

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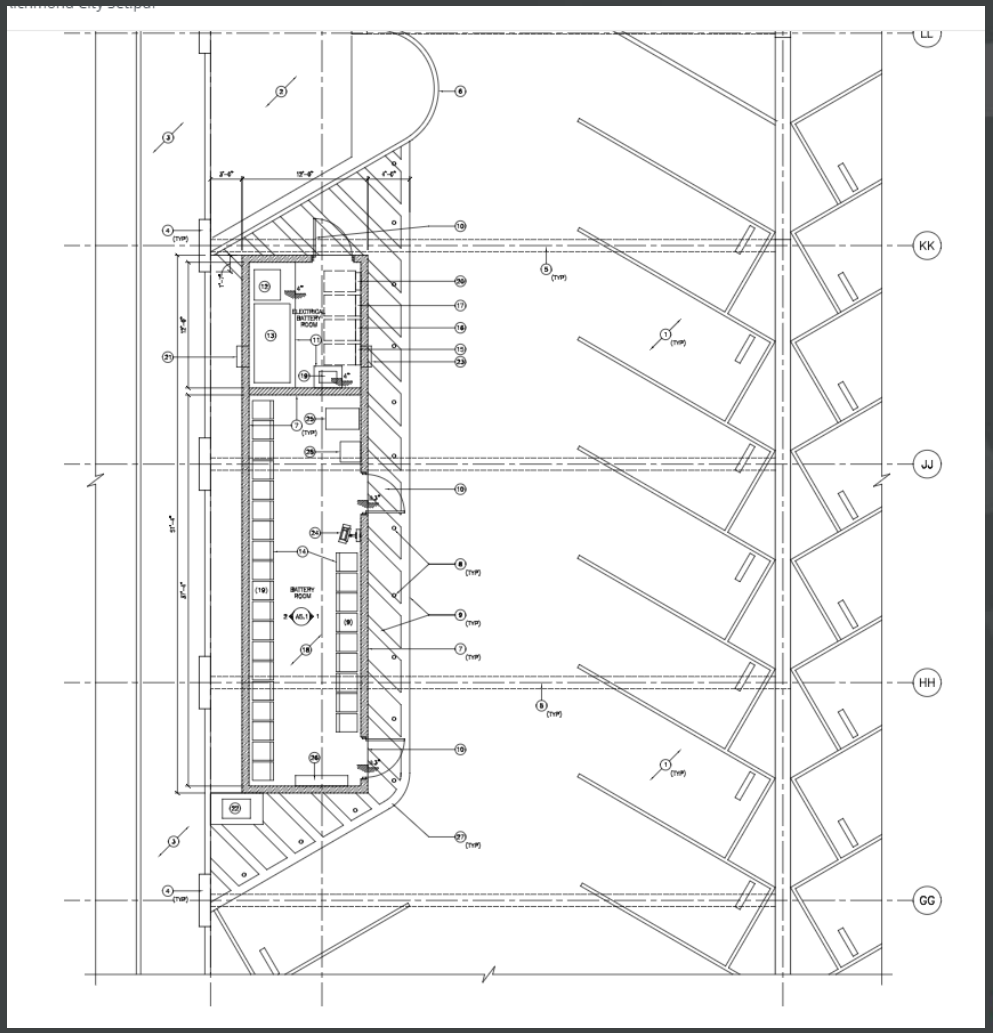
Battery Room inside parking garage



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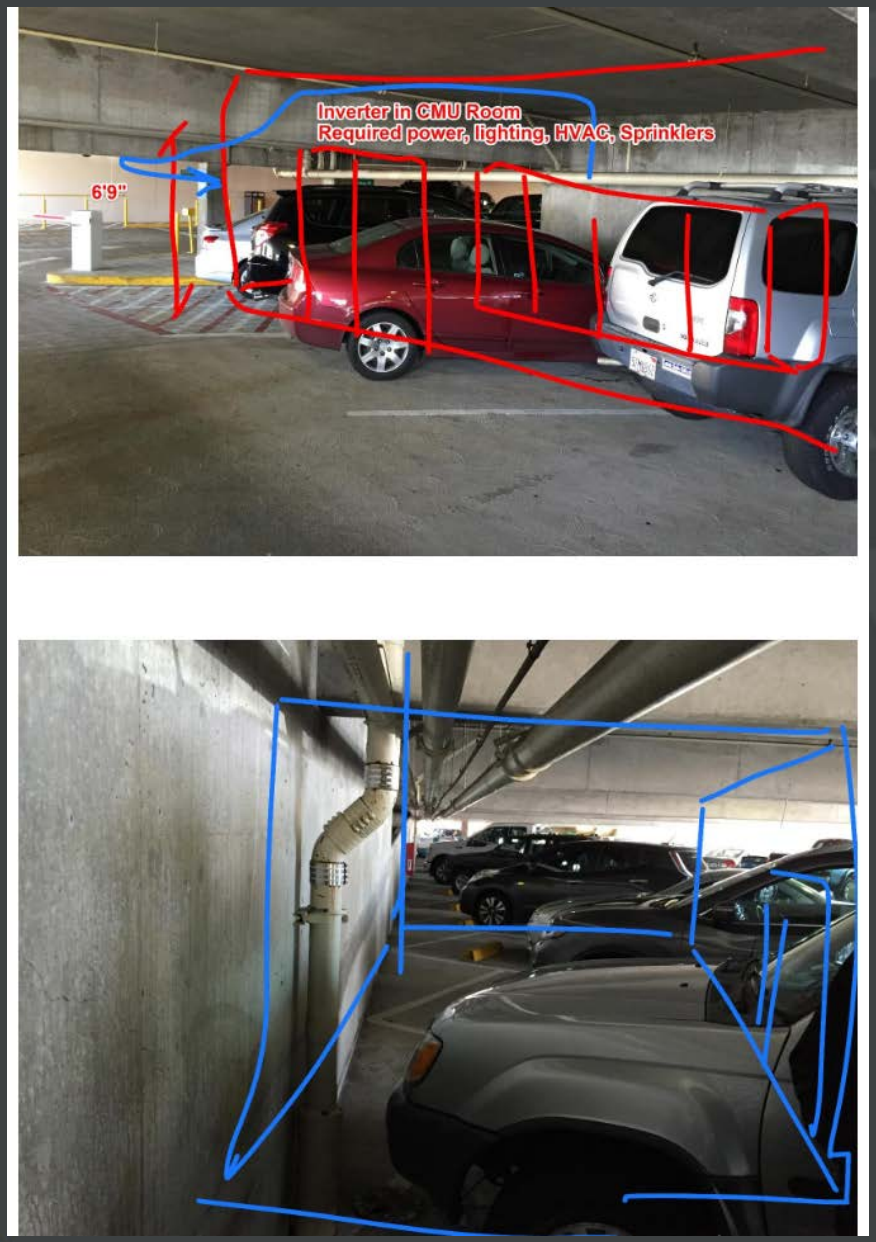
Images of location of battery room. Switched to the exterior wall of the parking garage.



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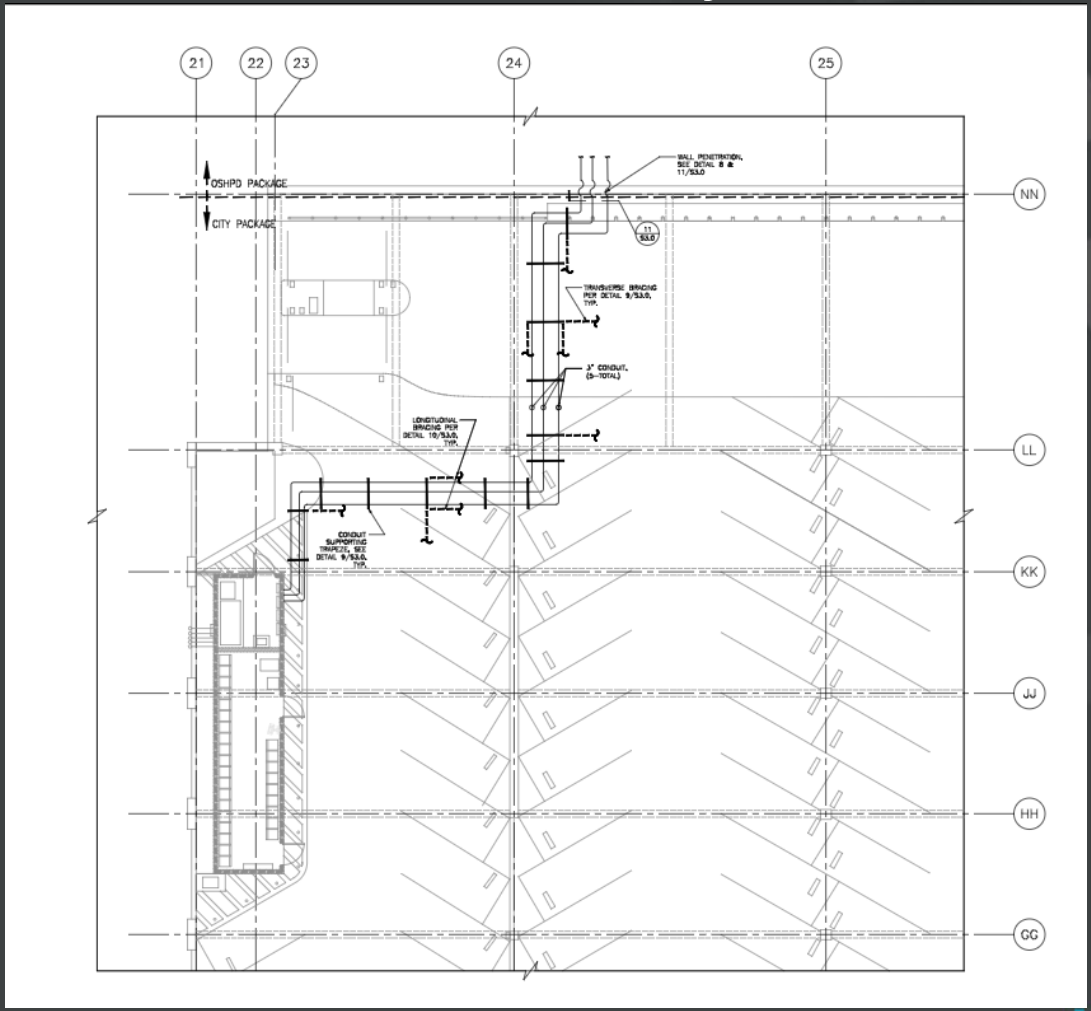
Overhead lines from the Battery Room to the C.U.P



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Images inside of parking garage

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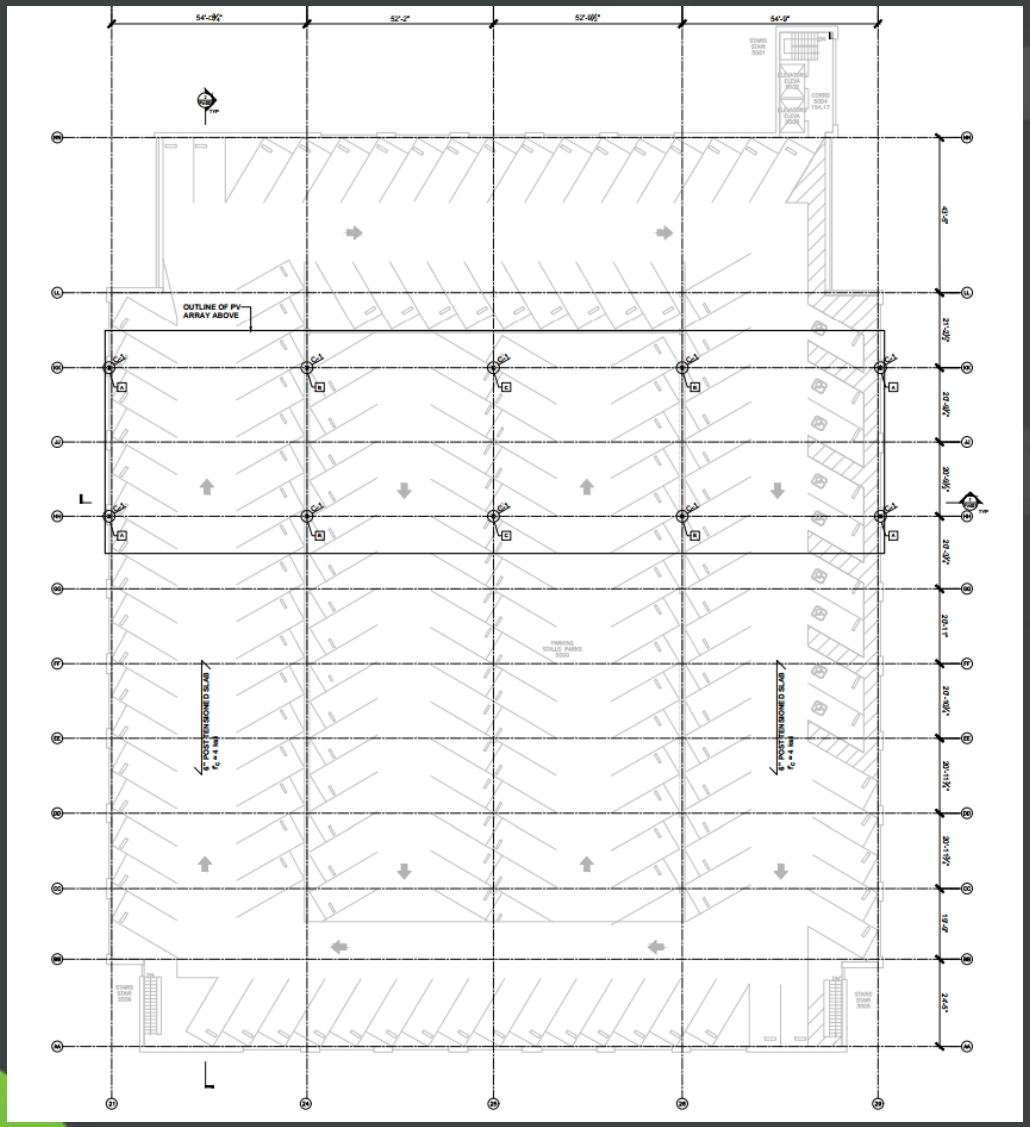
PV Array on top of parking structure



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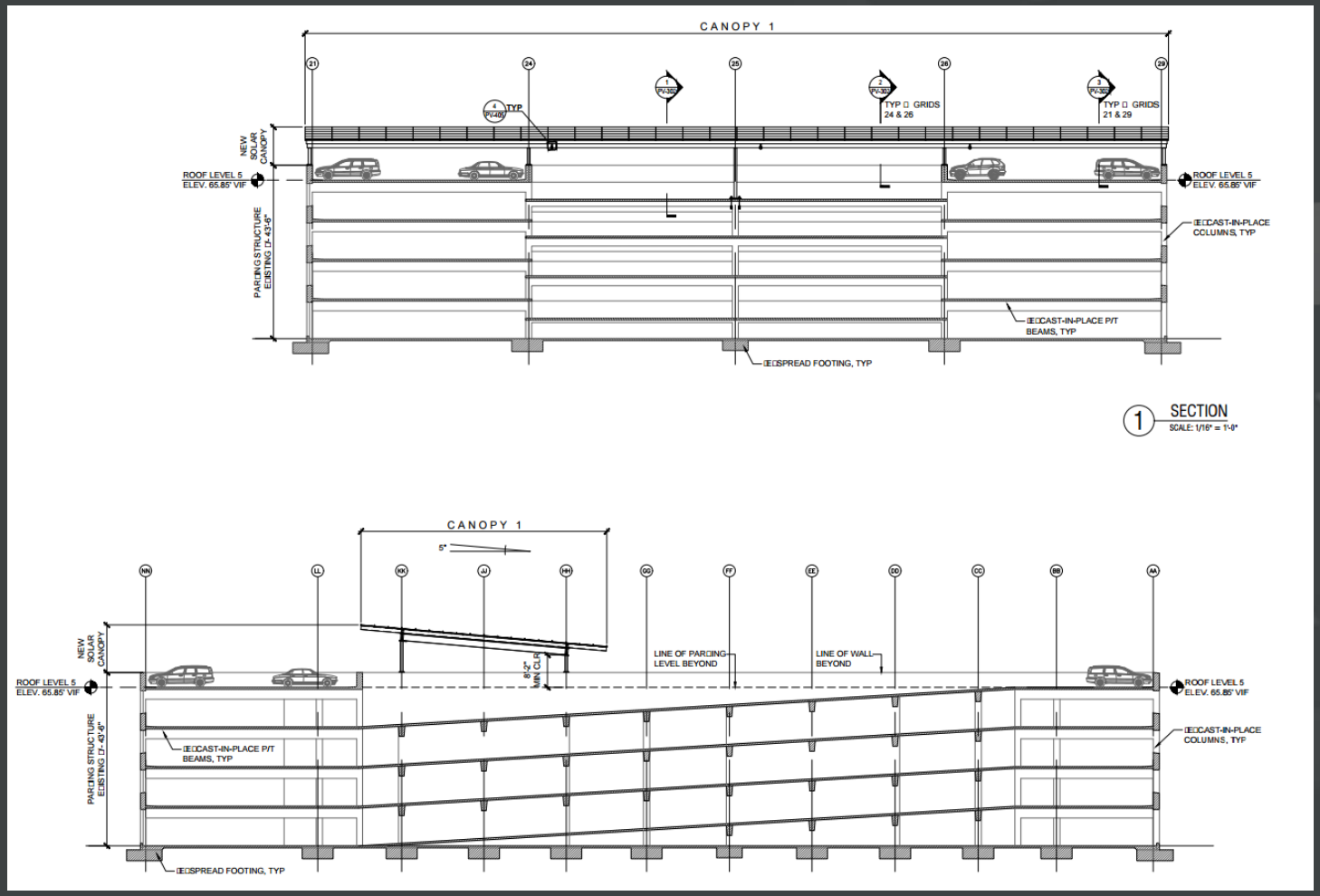
PV Array elevation drawing



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PV Array image

SOLAIRE

by SUNPOWER®

Skelly Electric since 1974

CLIENT: SKELLY ELECTRIC
HOST: KAISER PERMANENTE RICHMOND MEDICAL CENTER
CARPORT: LONG SPAN GARAGE 360
LOCATION: 901 NEVIN AVE, RICHMOND, CA 94801CO

PANELS: SUNPOWER 435W
OF PANELS: 936 PANELS
SYSTEM SIZE: 407.16 KWP DC
DATE: MAY 9, 2016
TILT: 5°

Array	Array Dimension	Module Config.	Total Panels	kWp DC	# of Piers
LB1	62' X 218'	18 X 32	576	250.56	10
LB2	62' X 218'	18 X 20	360	156.60	6
			936	**407.16**	**16**

GENERAL NOTES:

1. Result of easement reports and underground utilities may affect final placement of solar arrays.
2. Conflicting trees and other obstructions will have to be removed, trimmed, or relocated
3. Detailed analysis of the effect of shade on arrays has not been performed.
4. Soil analysis has not been performed
5. It is assumed that the site is not in a flood plain.
6. Structural Analysis of the Garage has not been performed

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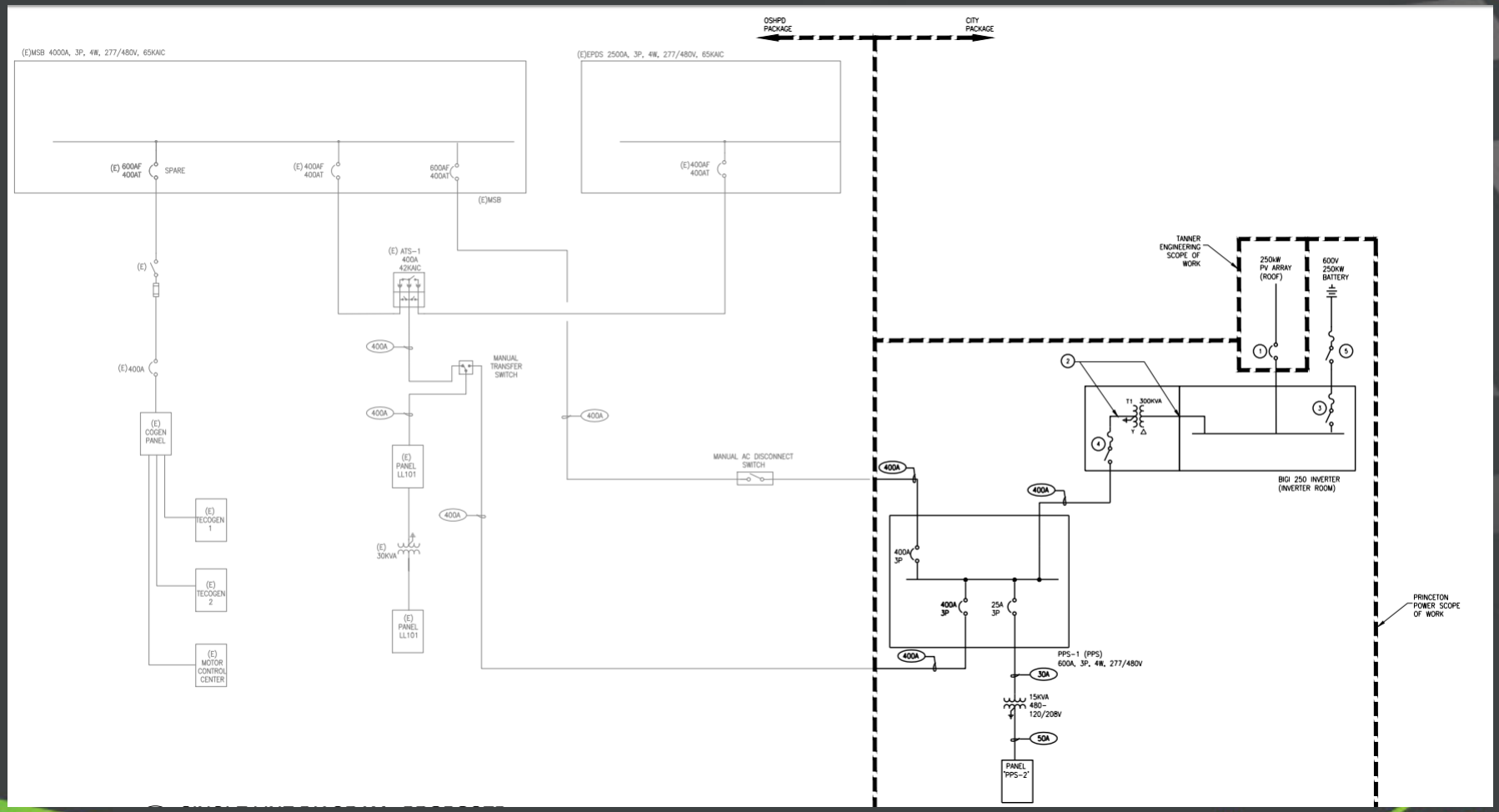
Single Line Diagram – Garage area



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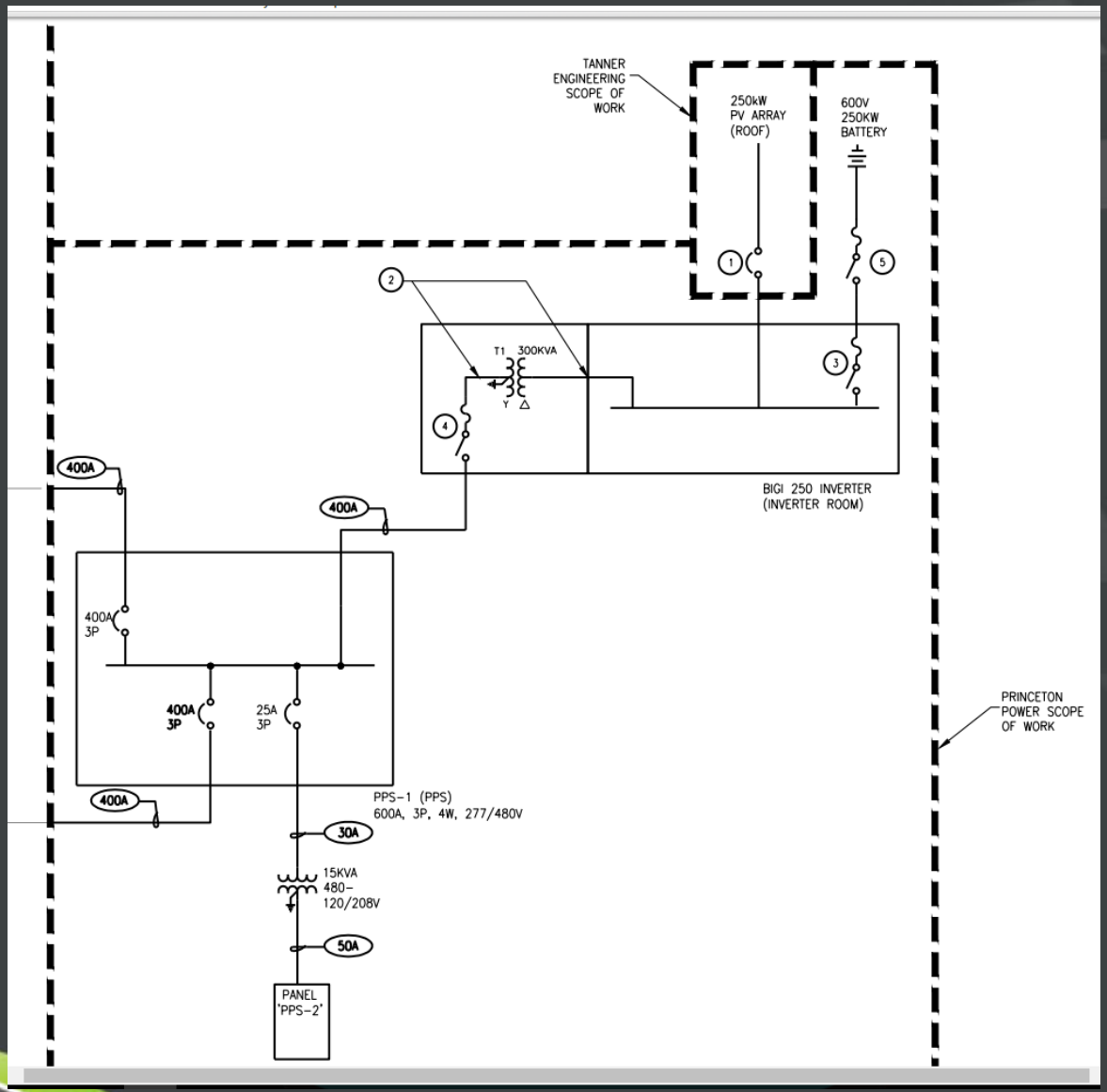
Single Line Diagram Zoom



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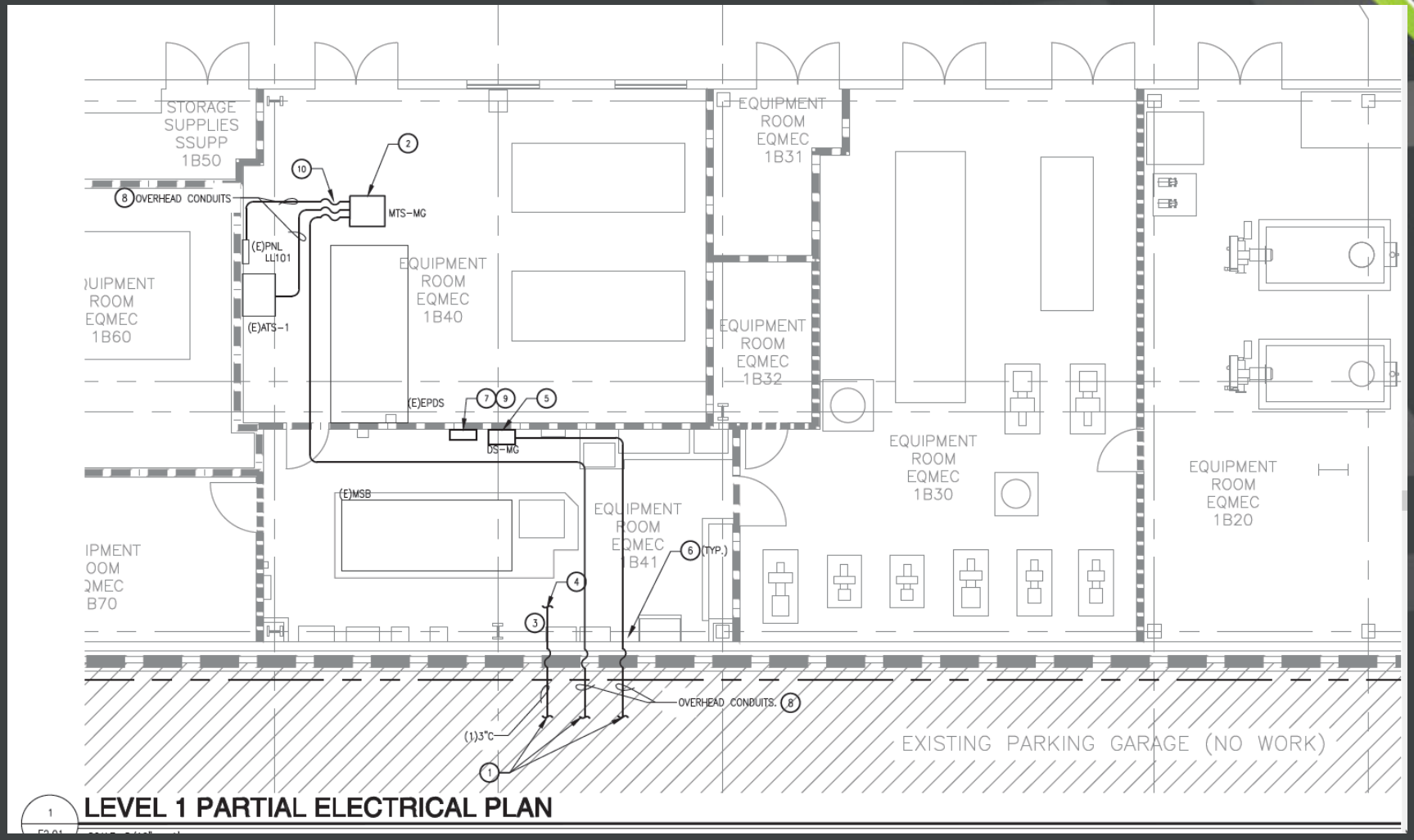
Electrical Plan View of C.U.P



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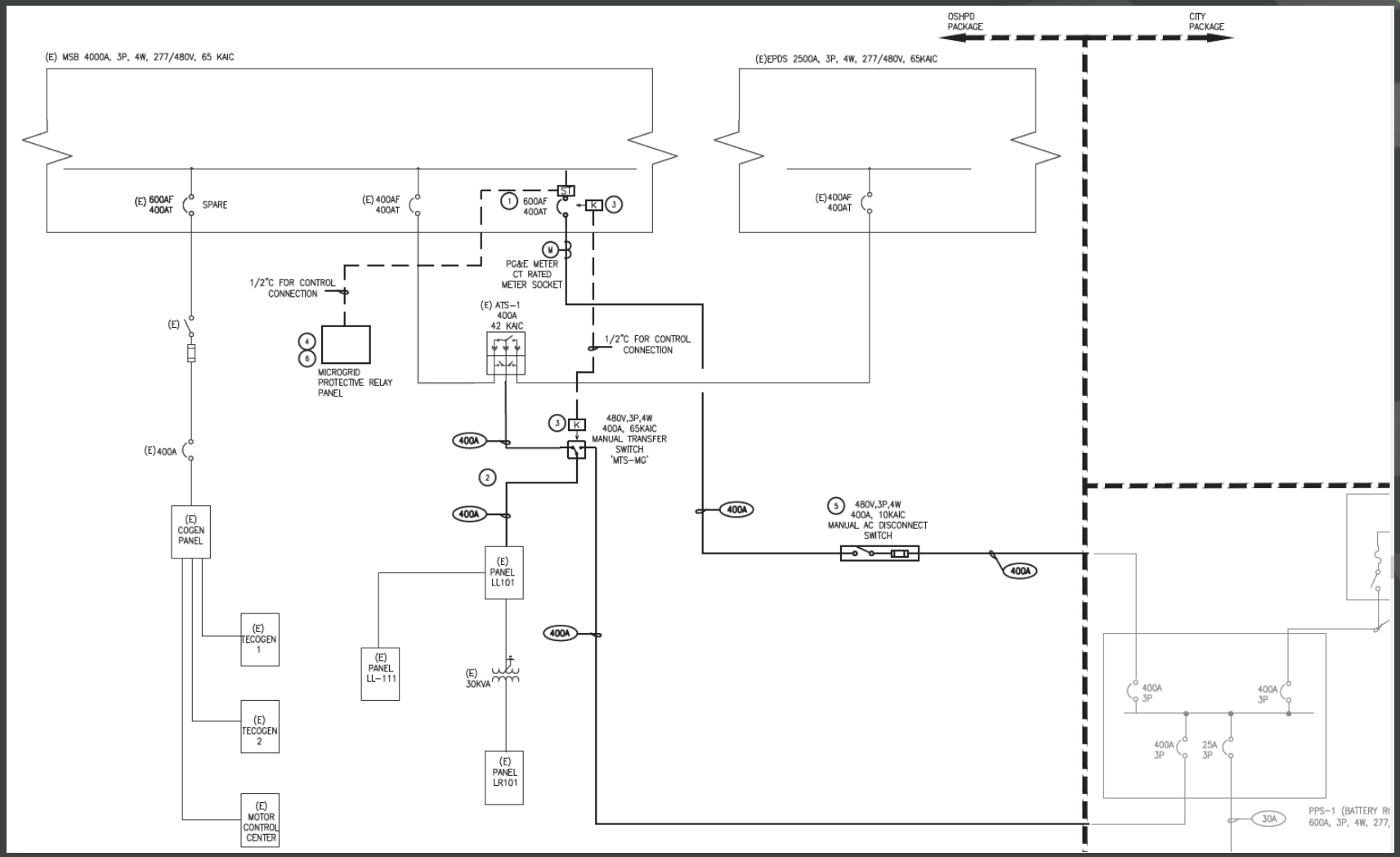
Single Line Diagram inside OSPHD area



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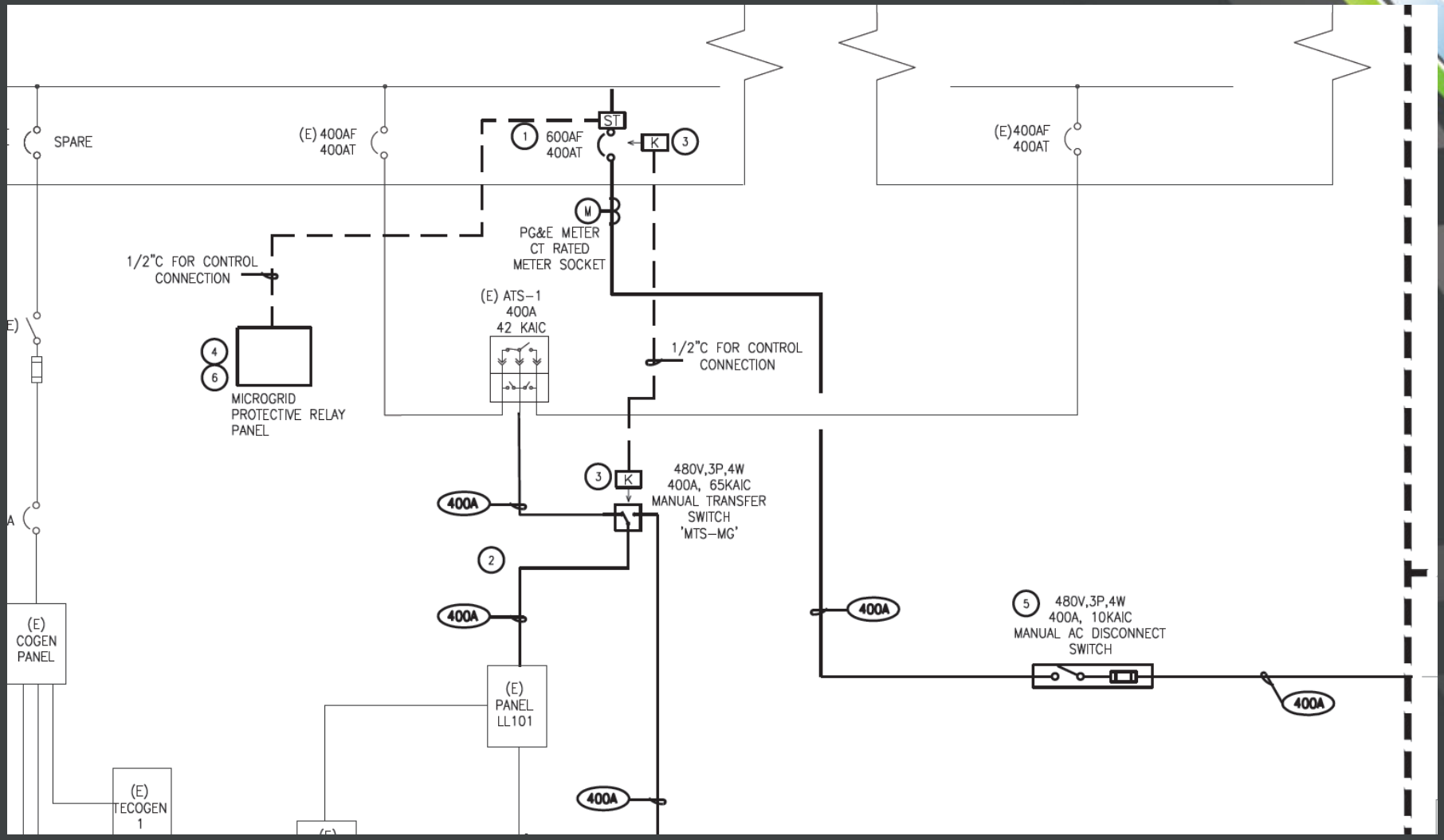
Single Line OSPHD area zoom



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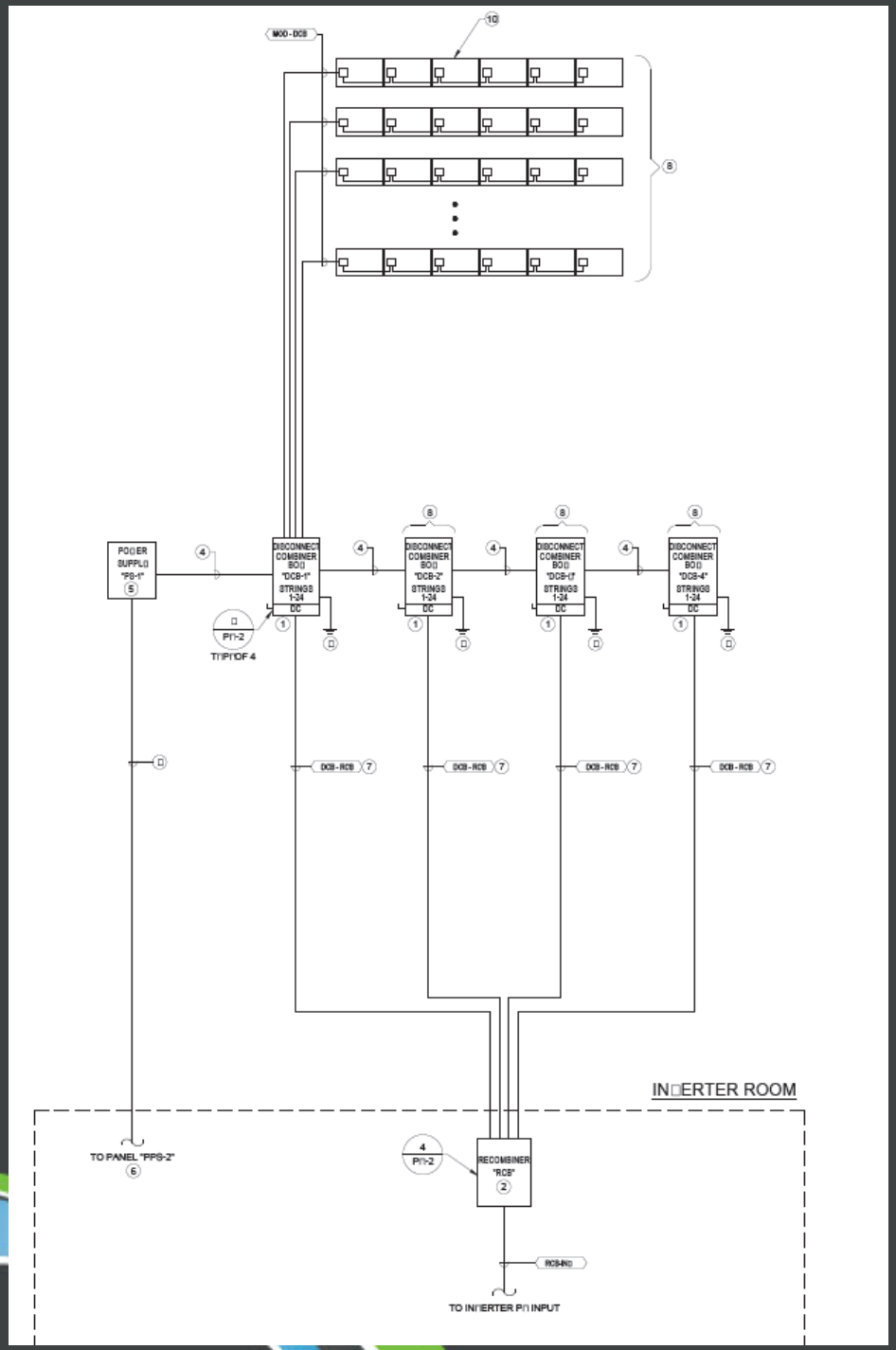

DC Single Line Diagram

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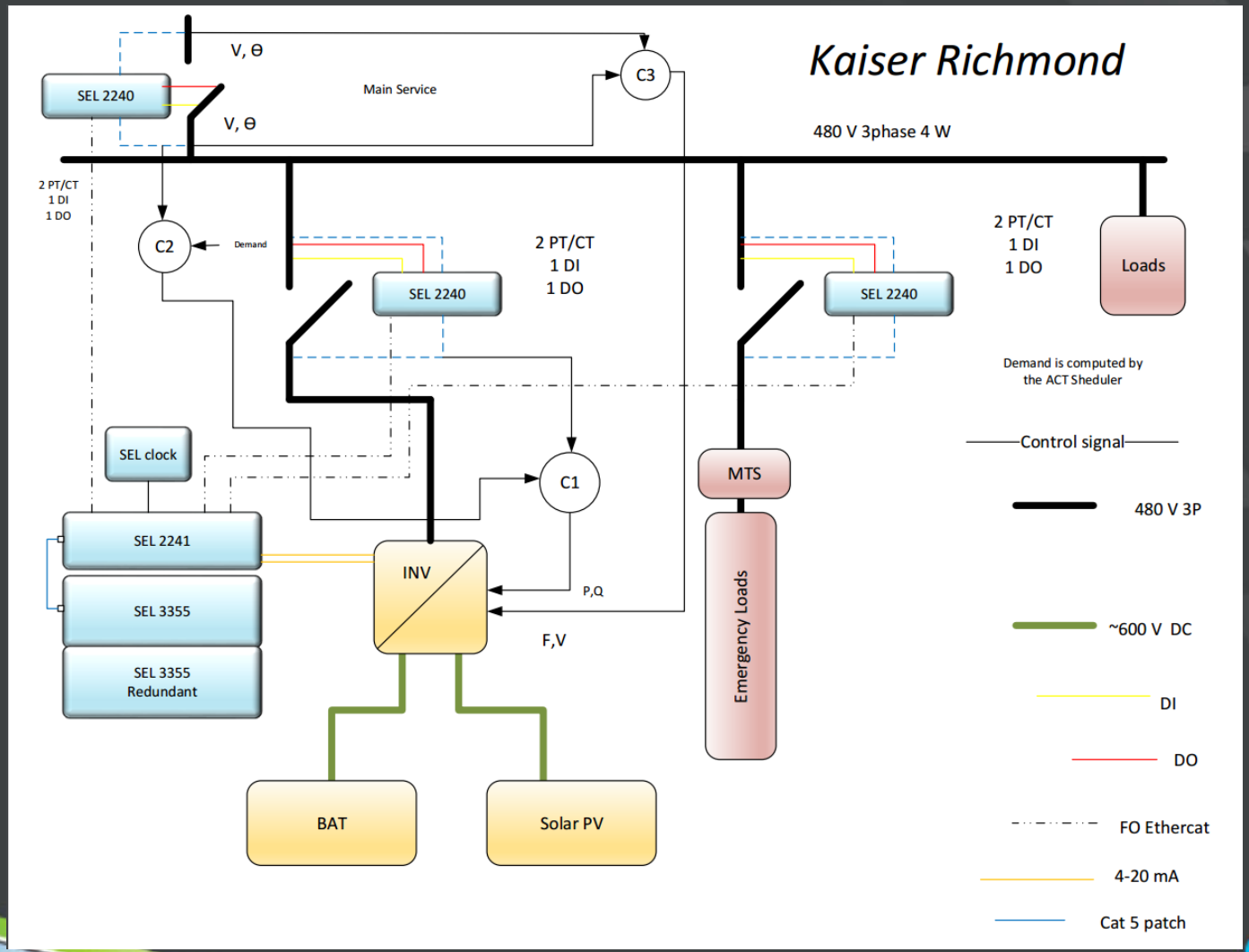
Monitoring Diagram



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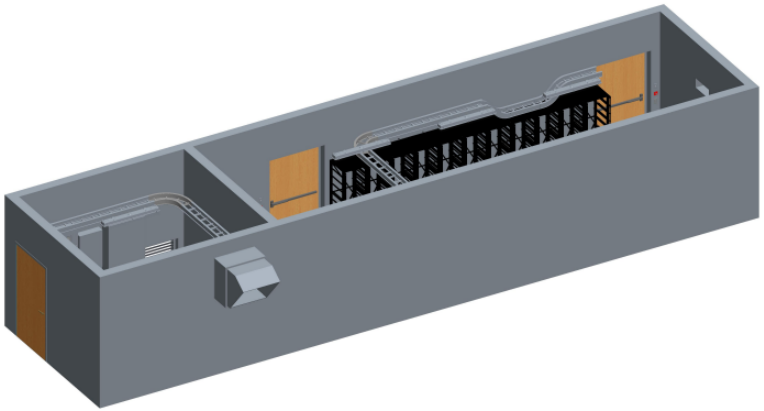
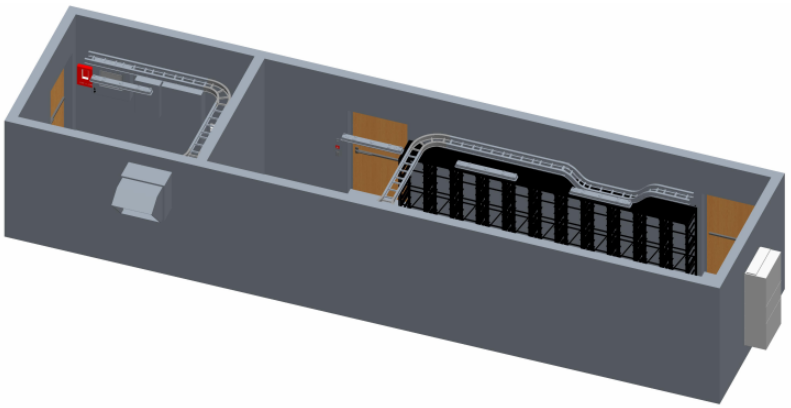
3D image of battery room

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	0.1	INITIAL RELEASE	05/10/16	AA
	0.2	ADDED CABLE TRAYS AND COMPONENTS	05/13/16	AA
	0.3	MODIFIED VIEWS	06/09/16	AA
	0.4	ADDED FAN SHROUD AND HOOD, CHANGED FAN TO 35 IN., WALL HOLE FOR EXHAUST CHANGED TO 35X35 IN., INTAKE MOVED TO 3 IN. ABOVE GROUND	6/21/16	SB





APPROVALS	INITIAL	DATE
PREPARED BY	MK	05/10/16
REVIEWED BY	NB	05/10/16
APPROVED BY	AA	05/10/16

PRINCETON POWER SYSTEMS

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Lawrenceville NJ, 08648

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(609) 751-9225

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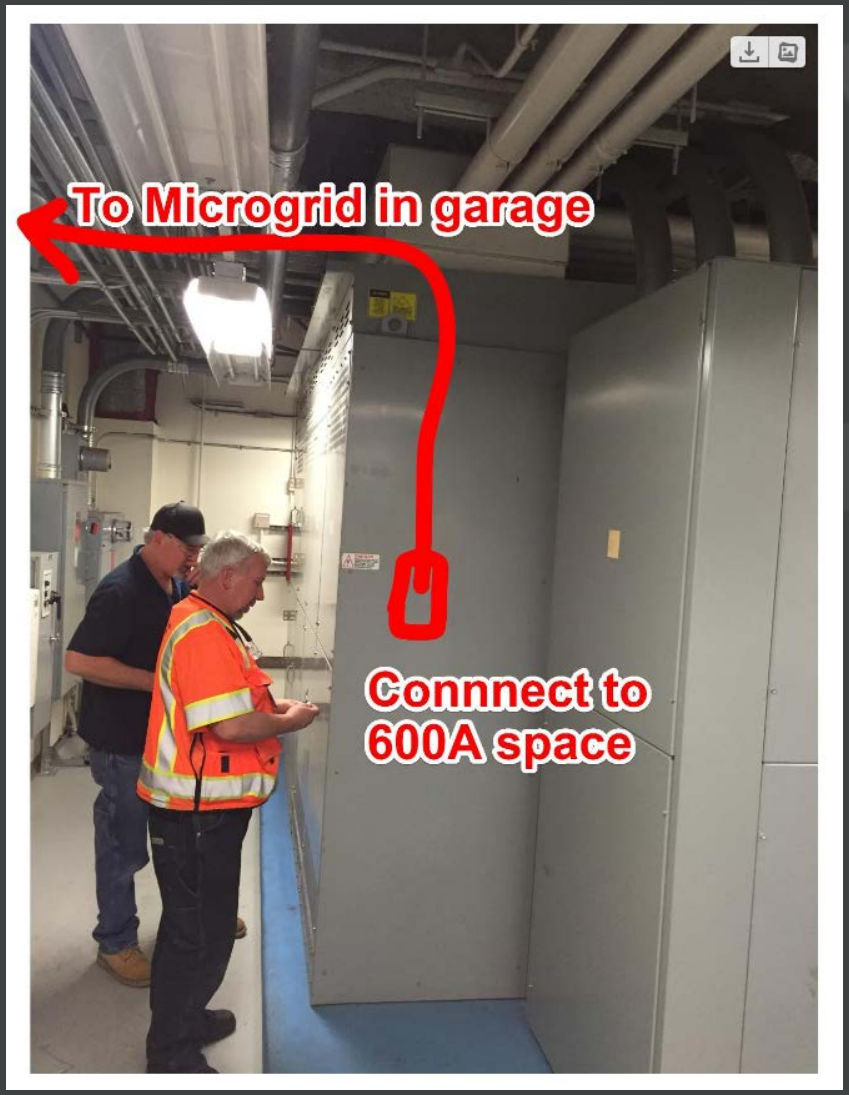
Backside of Subpanel inside C.U.P.



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Life and Safety Panel

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Main Subpanel Tie-in Point

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Special Consideration- Office of Statewide Health Planning and Development

- Governs all hospital design, construction, and operation
- Special emphasis on:
  - Electrical system safety and effectiveness
  - Life and Safety/Critical circuit Primacy
  - Recognize and incorporate involving technologies and create appropriate standards
- *EQUALS: Extra, critical layer of review*

Conclusions

- Hospital microgrid design is challenging
- However, upside value is great
  - Hospitals are disproportionate users of energy
  - Hospitals are under substantial financial strain
  - Hospitals are arguably some of the most critical state facilities
- Proof of concept will yield:
  - Rate payer value from hospital reliability
  - Regional power quality improvement
  - Decreased reliance on fossil fuel and consequent emissions

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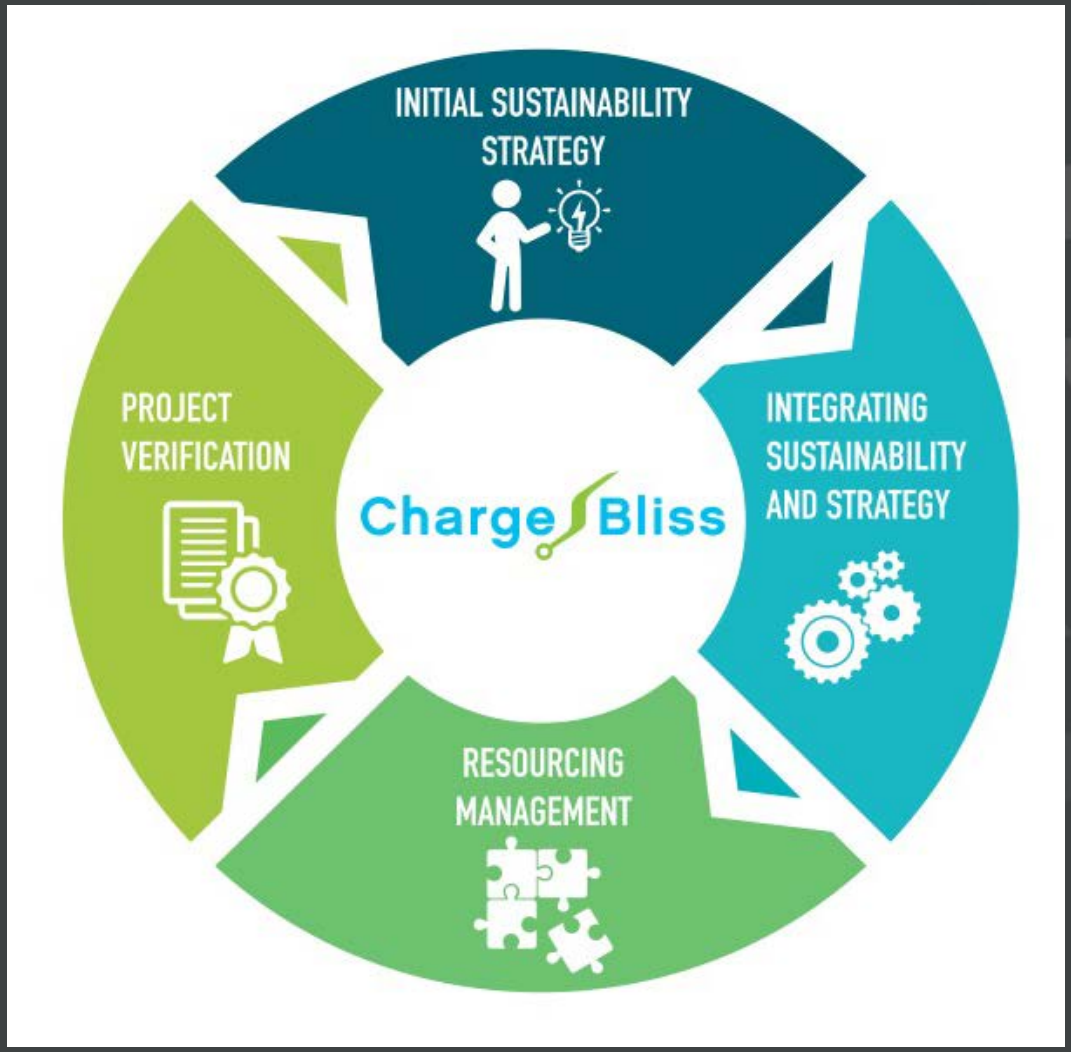

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